

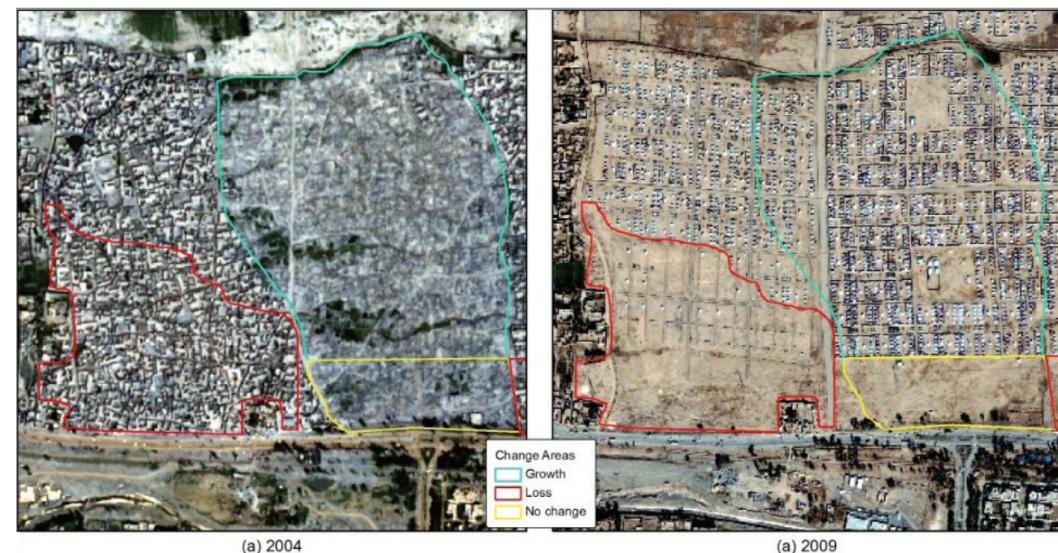
GMM based Change Detection Framework Using Very High-resolution Satellite Imagery

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What is Change Detection?

Change detection can be defined as the process of identifying differences in the state of an object or phenomenon by observing it at different times

- Pixel-based method
- Object-based method
 - Grid-based method
 - Segmentation-based method

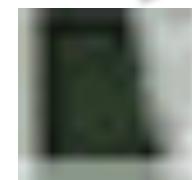
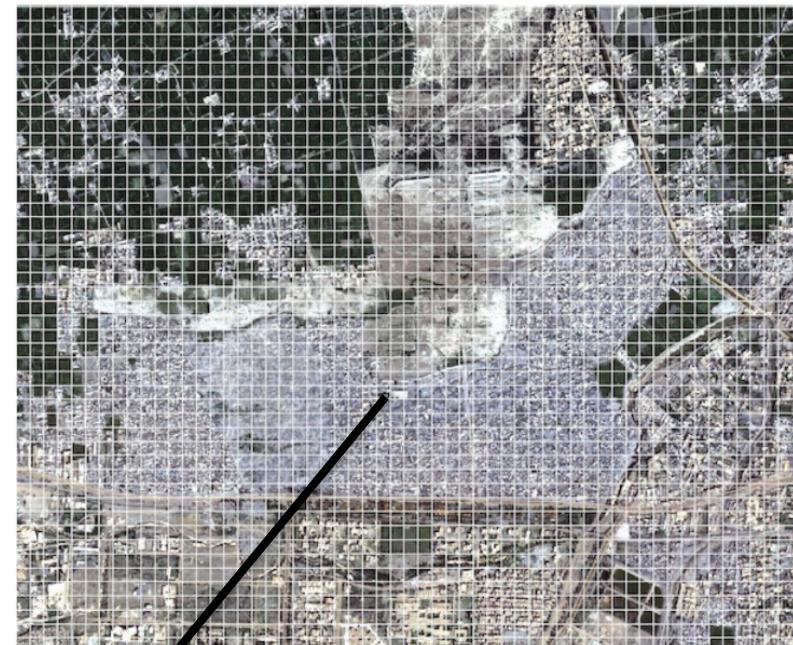


Major settlement changes identified by manual interpretation (Kacha Garhi camp, Pakistan).

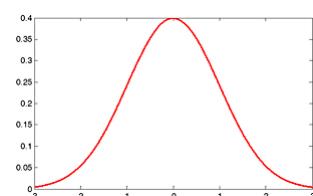
One Existing Grid-based method^[1]

Probabilistic Change Detection Framework

- Divide the image into grids
- Model the data from each grid as a Gaussian distribution. Therefore, at each grid there are two Gaussian distributions $P_{t1}(i), Q_{t2}(i)$ for time t1 and t2
- For each grid i, compute the distance between Gaussian distributions $P_{t1}(i), Q_{t2}(i)$
- Clustering the distance data by modeling it as a statistical distribution, where different clusters correspond to various degrees of change

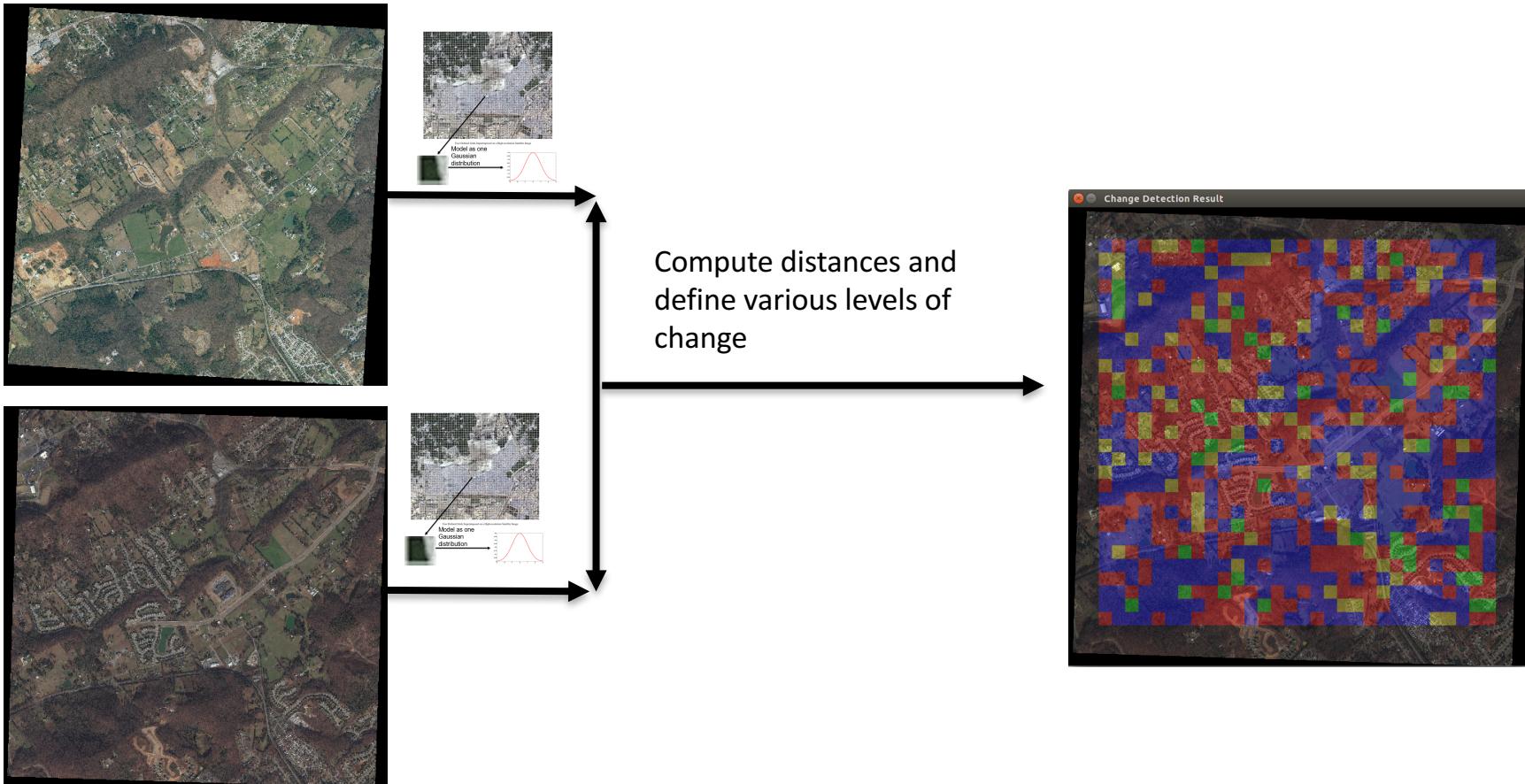


Model as one Gaussian distribution

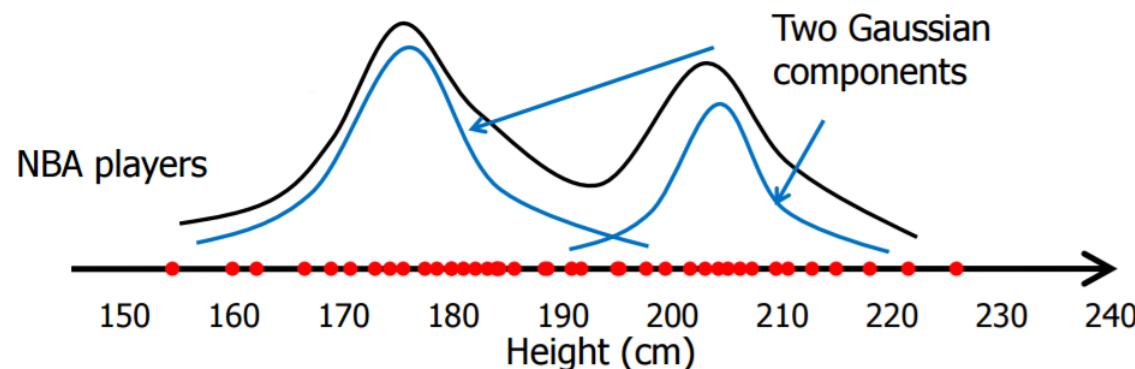


[1] Vatsavai, Ranga R., and Jordan Graesser. "Probabilistic change detection framework for analyzing settlement dynamics using very high-resolution satellite imagery." *Procedia Computer Science* 9 (2012): 907-916.

One Existing Grid-based method



GMM: Gaussian Mixture Model



- Represent the dist. with a mixture of Gaussians

$$p(x) = \sum_{j=1}^K P(z=j)p(x|z=j)$$

z : a membership r.v. indicating which Gaussian that x belongs to.

Weight of j -th Gaussian. Often notated as w_j

z is a discrete variable, so we use probability mass P .

The j -th Gaussian, parameter: (μ_j, σ^2_j)

The slide is taken from Zhiyao Duan & Bryan Pardo, Machine Learning Course, University of Rochester

Extending the existing method using GMM

- As it is more practical that there are more than one object in each grid. Now we model each grid by one GMM instead of one Gaussian Distribution

Possible Challenges

- How to compute the distance between two GMMs, various methods^[1,2,3]to explore
- Identify the number of components in each GMM
- Select suitable threshold value to identify changes is difficult, suffering mis-detection or over-detetion

[1] Goldberger, Jacob, Shiri Gordon, and Hayit Greenspan. "An efficient image similarity measure based on approximations of KL-divergence between two Gaussian mixtures." *Computer Vision, 2003. Proceedings. Ninth IEEE International Conference on*. IEEE, 2003.

[2] Beecks, Christian, et al. "Modeling image similarity by gaussian mixture models and the signature quadratic form distance." *2011 International Conference on Computer Vision*. IEEE, 2011.

[3] Hershey, John R., and Peder A. Olsen. "Approximating the Kullback Leibler divergence between Gaussian mixture models." *2007 IEEE International Conference on Acoustics, Speech and Signal Processing-ICASSP'07*. Vol. 4. IEEE, 2007.